ATLAS Pixel IBL QA

In and around SR1

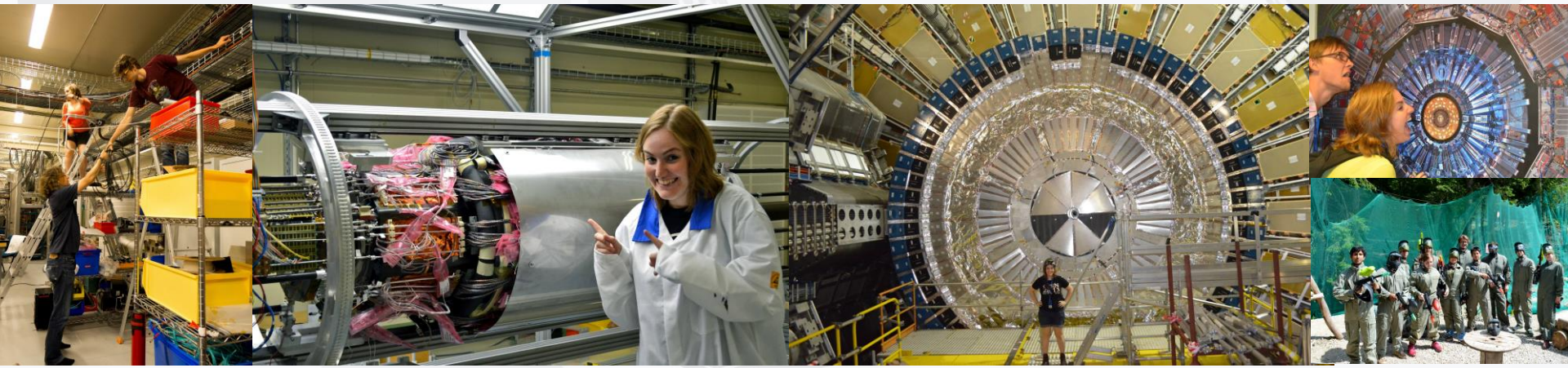
Overview

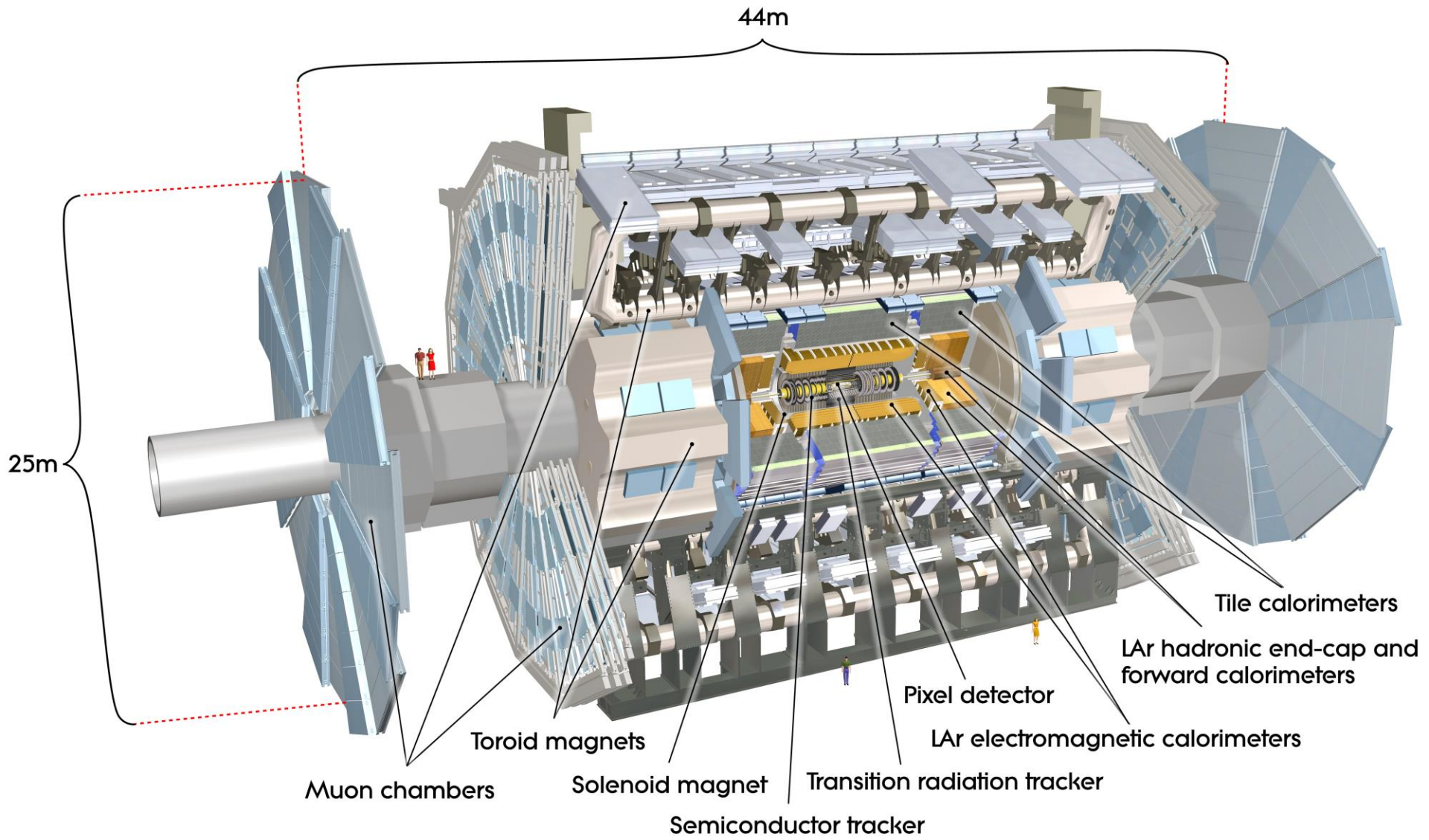
A selection from the ATLAS Pixel Upgrade – what, when, who, why, how?

How you too can build your very own IBL!

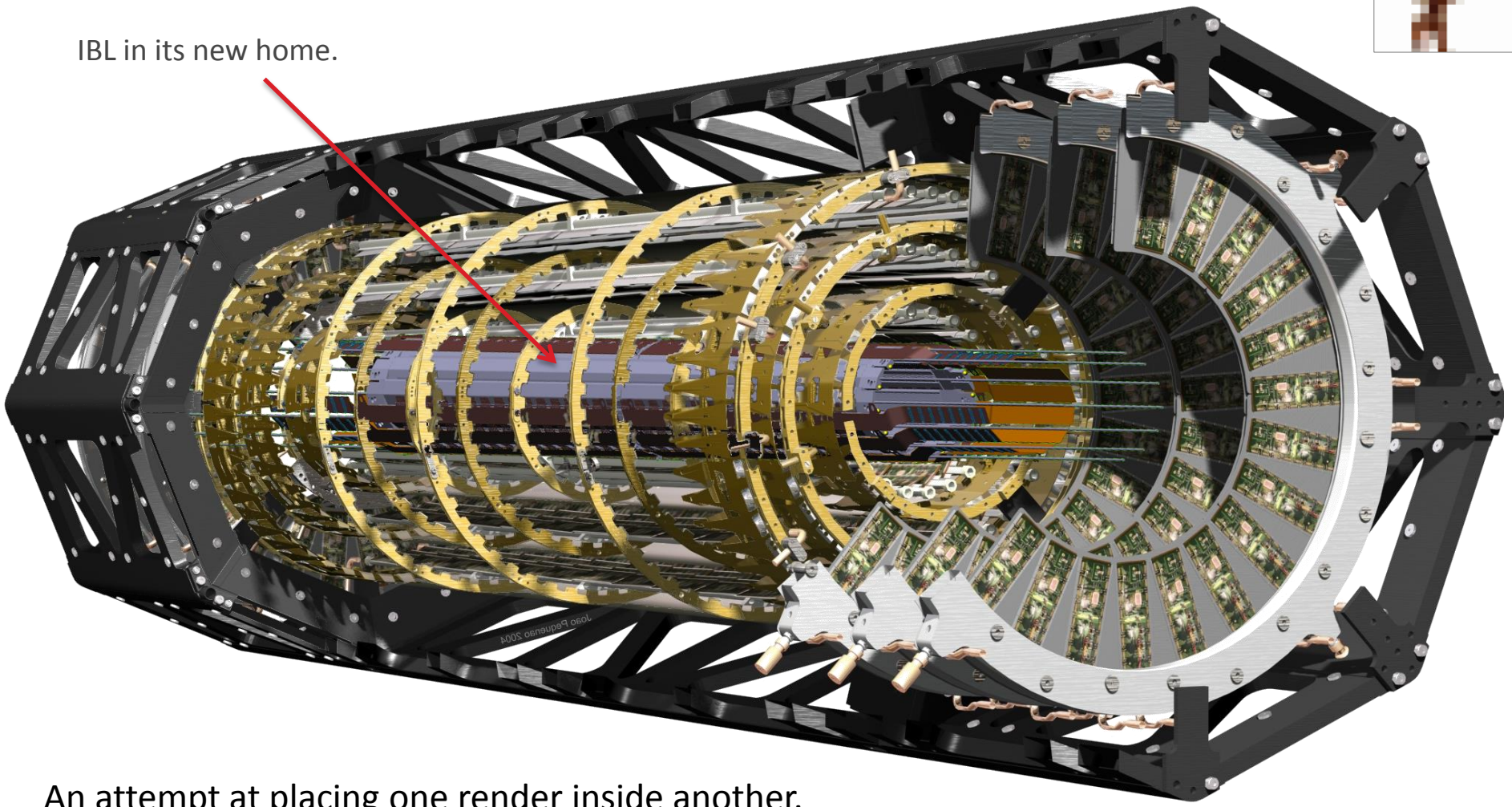
What have I actually been doing? Part 1 – Analyse This

What have I actually been doing? Part 2 – A Tale of Two Noises

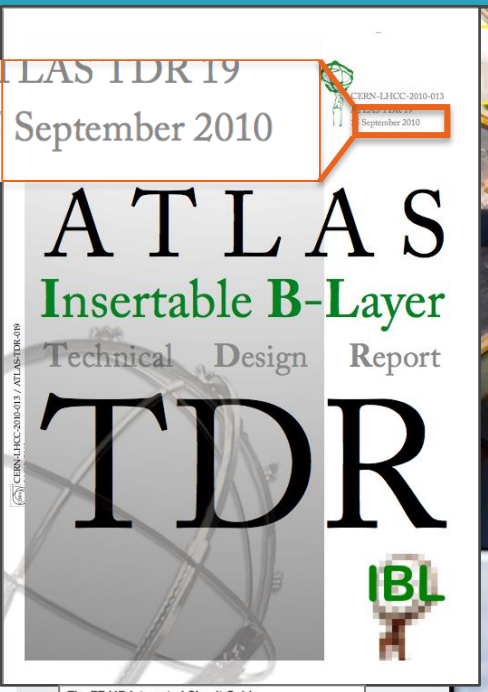


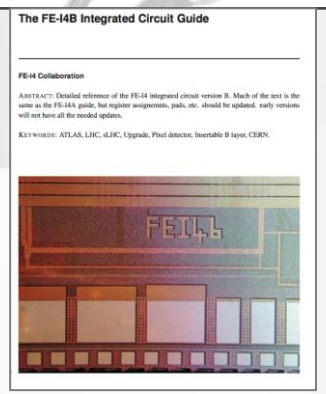

44m
25m
Tile calorimeters
LAr hadronic end-cap and forward calorimeters
Pixel detector
LAr electromagnetic calorimeters
Toroid magnets
Muon chambers
Solenoid magnet
Transition radiation tracker
Semiconductor tracker

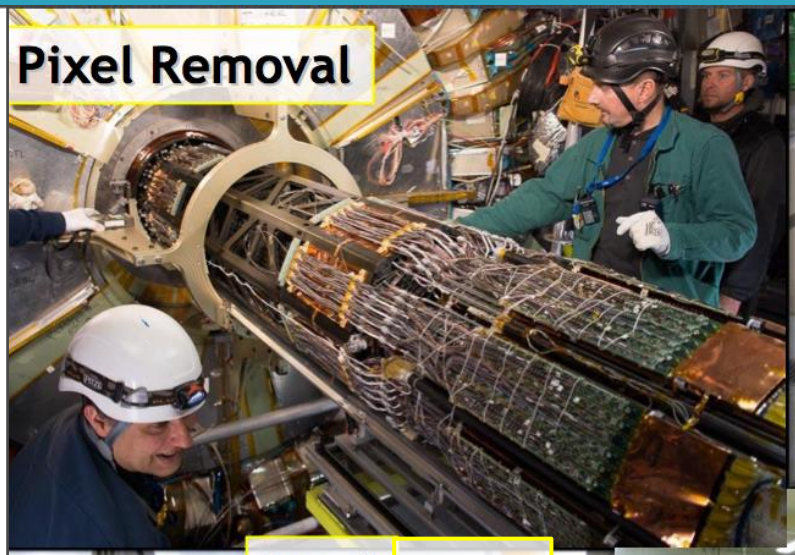
IBL in its new home.



An attempt at placing one render inside another.
Not shown here: services, beam pipe, IBL Support Tube (IST), most of the existing Pixel.





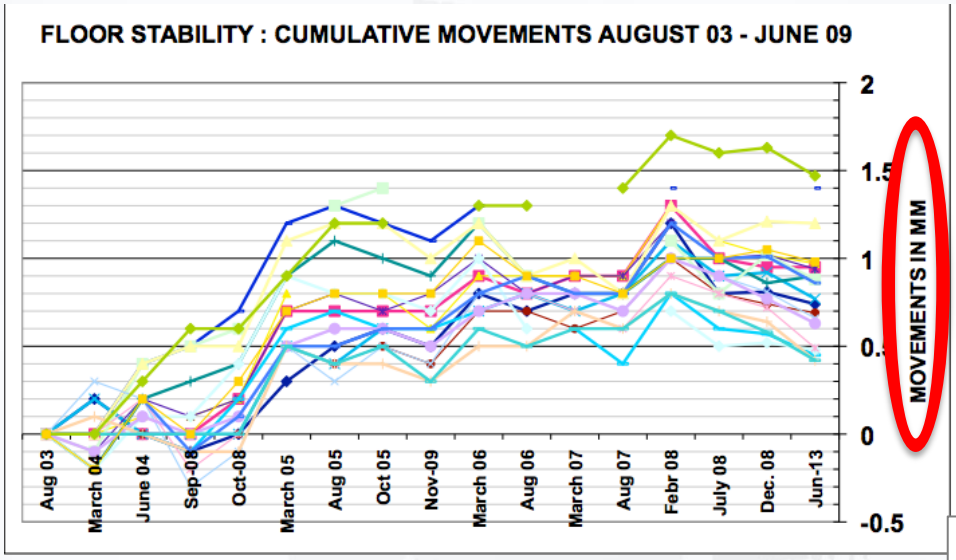


2007 – FEI4 task force

2008 – IBL task force

2010 – Technical Design Report

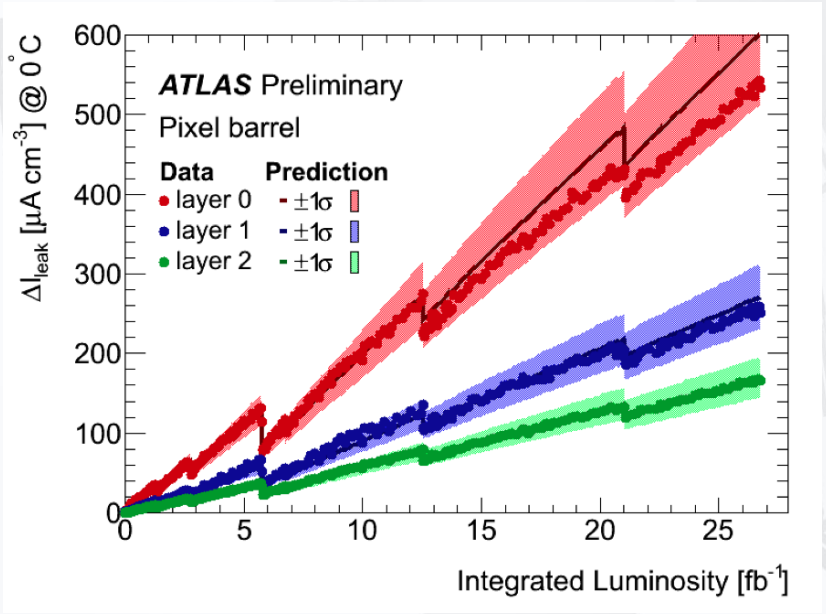
2013 - Construction and integration

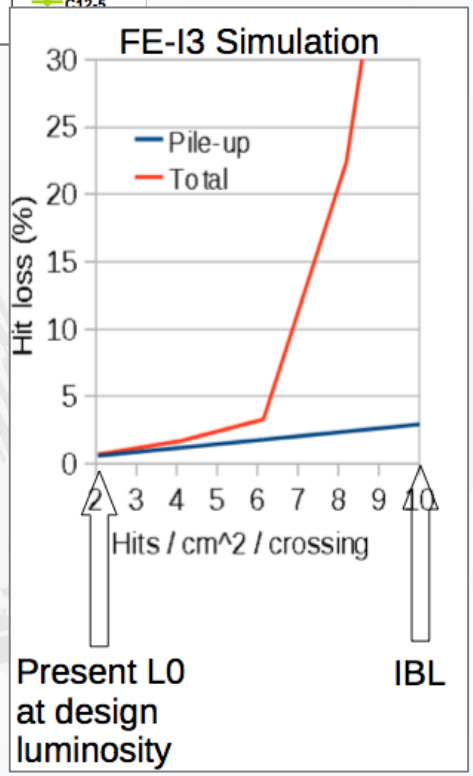


Why are we bothering?

Compensate for the loss of full coverage as the detector reaches higher luminosities.

The LHC has delivered ~30fb^{-1} or 6x10^{13} 1MeV n_{eq}/cm^2. Pixel will last for of the order of 10 times more radiation.

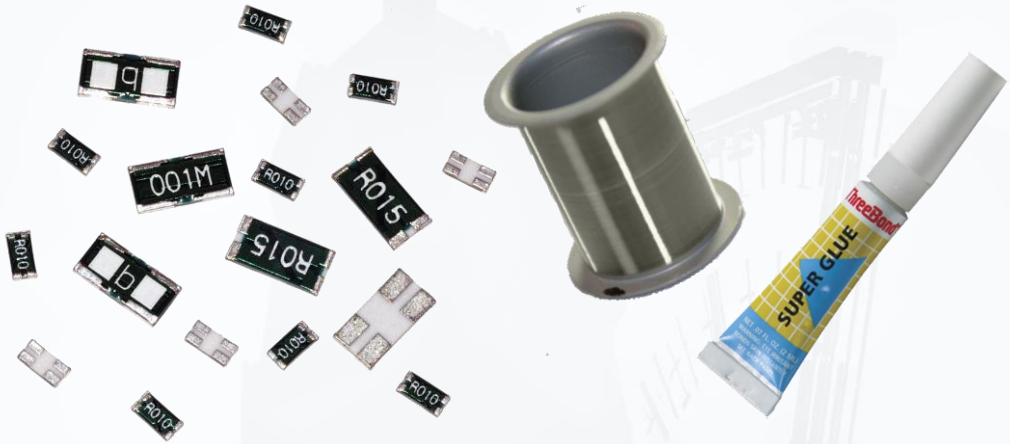




The HL-LHC (Phase-II) upgrade also requires a tracker that is more radiation hard.

IBL is a way of testing these new technologies whilst providing a higher sensitivity for B-tagging for the next data taking period.

Prof. D. Bortoletto, *Detectors for Particle Physics: Semiconductor detectors, CERN Summer Student Lectures 2013*



GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

ISSUGE

CERN

universitätbonn

Centre Nacional de Microelectrónica IMB

Fraunhofer IZM

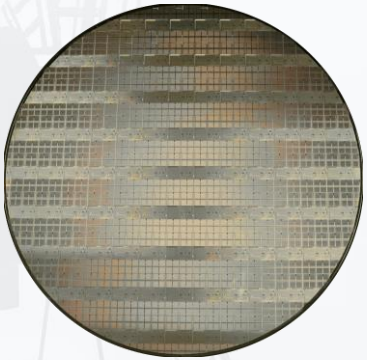
FONDAZIONE BRUNO KESSLER

UNIVERSITÉ DE GENÈVE

BERGISCHE UNIVERSITÄT WUPPERTAL · 1972 ·

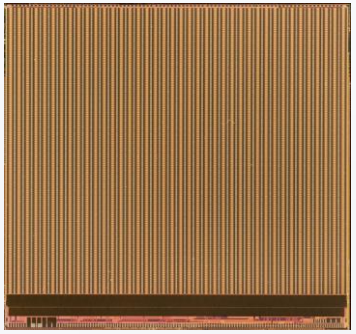
Insertable B-layer shopping list

- Skilled individuals at established institutes across the world.
- Planar and 3D Silicon Sensors
- FE-I4B readout chip x 32 x 14
- Module and stave kapton flex PCB's
- Carbon foam/fibre stave
- Surface mount components
- 0.1 um aluminium thread
- Lots of glue!

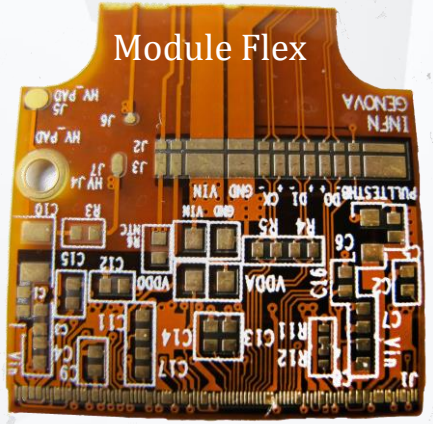


Silicon sensors

FE-I4B



Module Flex



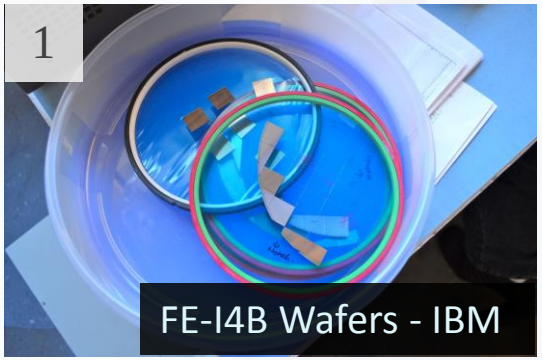
Carbon stave

(Here's one we made earlier)

Stave flexs

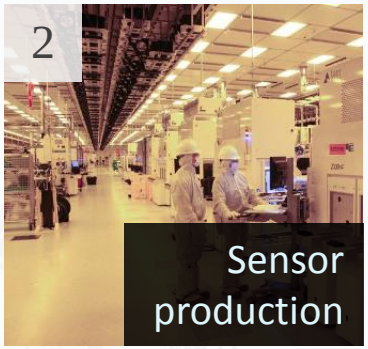
You too can build your very own IBL – in 10 easy steps!

1



FE-I4B Wafers - IBM

2

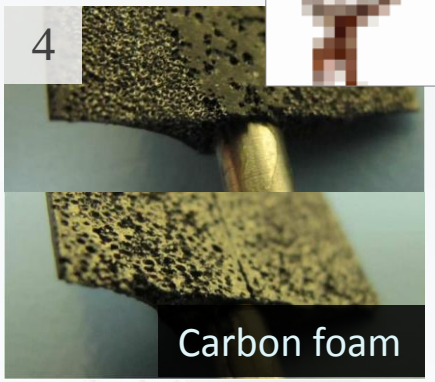


Sensor production

3

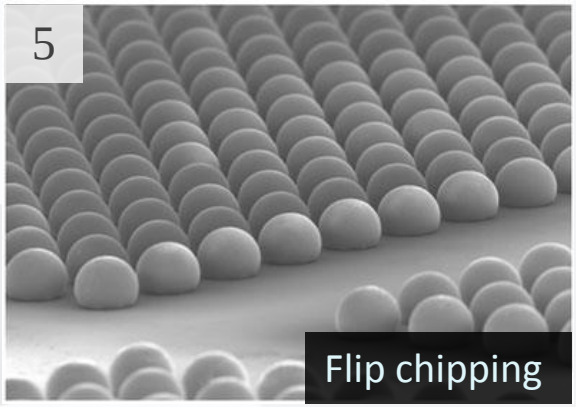
Kapton flexs (module and stave)

4



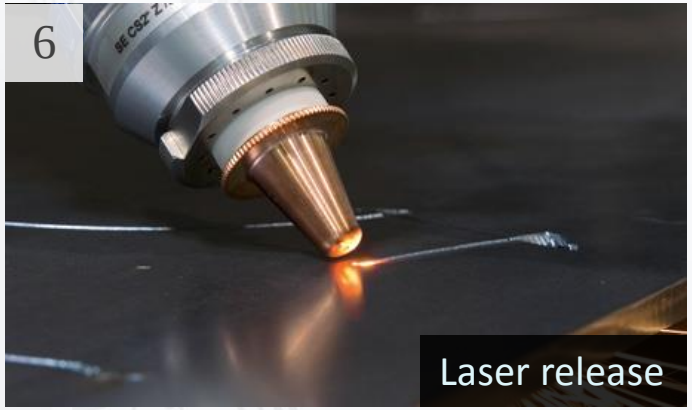
Carbon foam

5



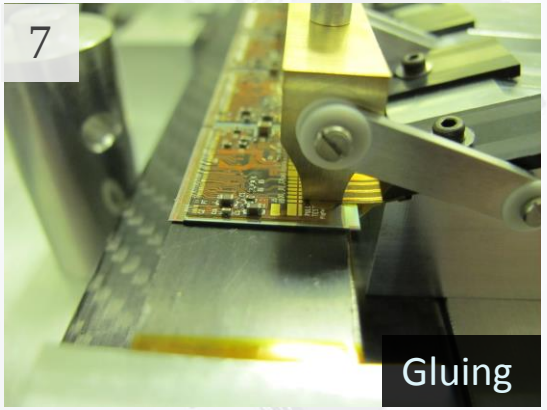
Flip chipping

6



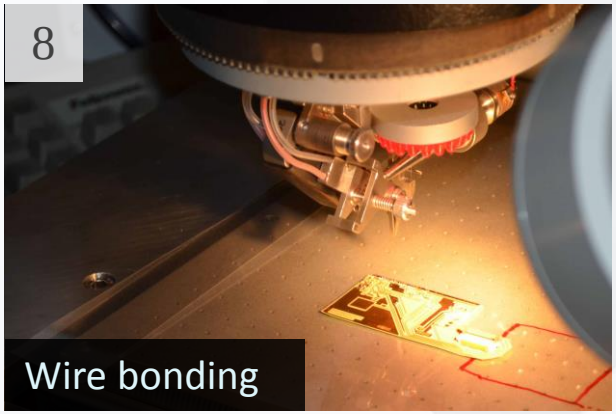
Laser release

7



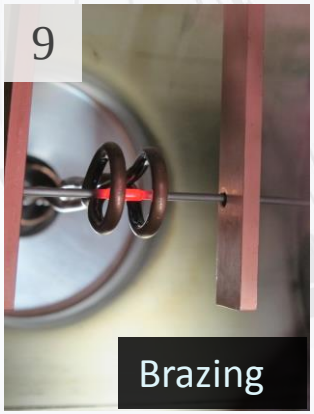
Gluing

8



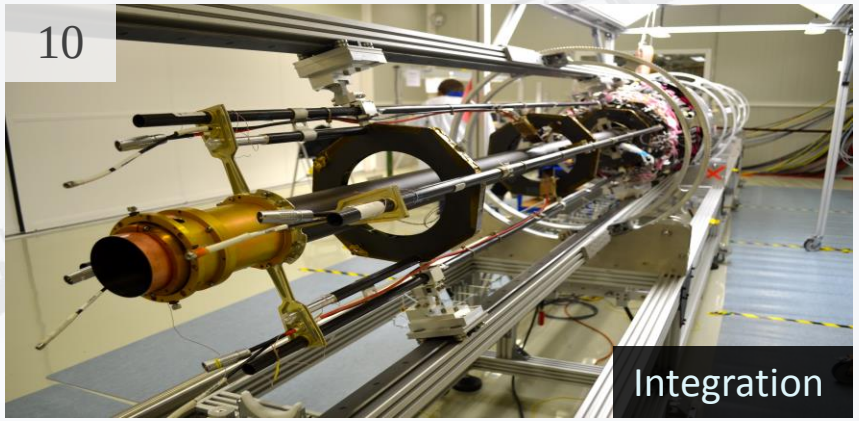
Wire bonding

9

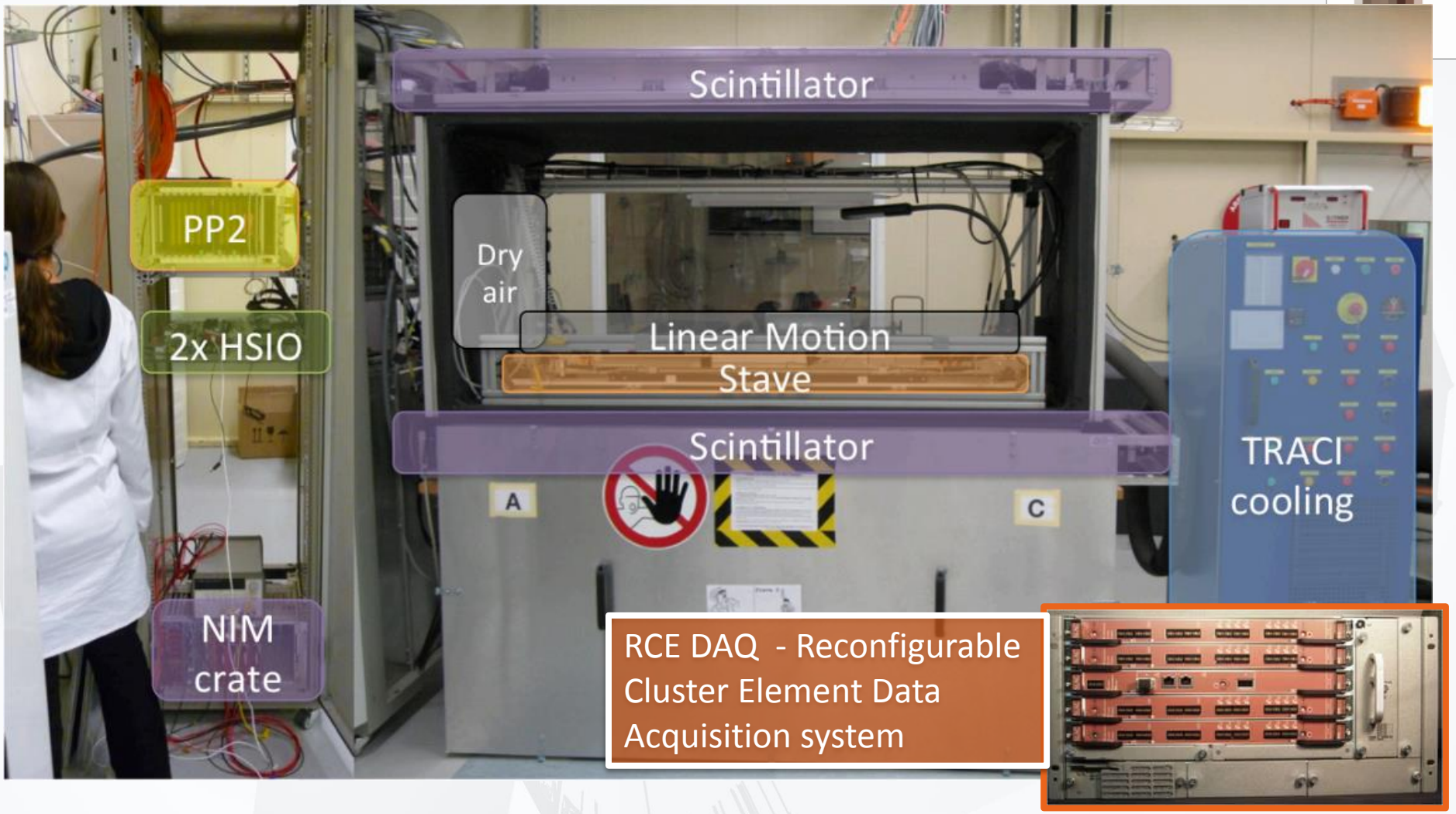


Brazing

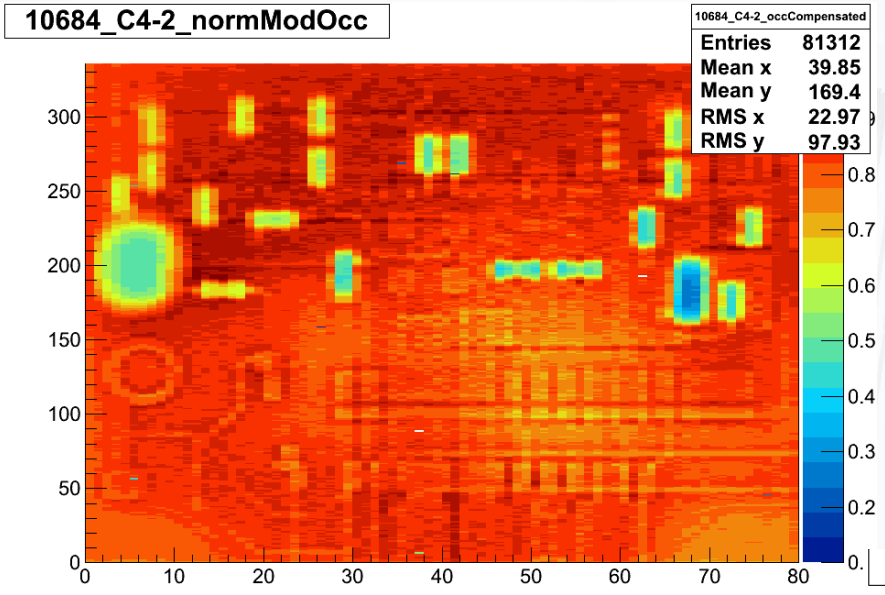
10



Integration

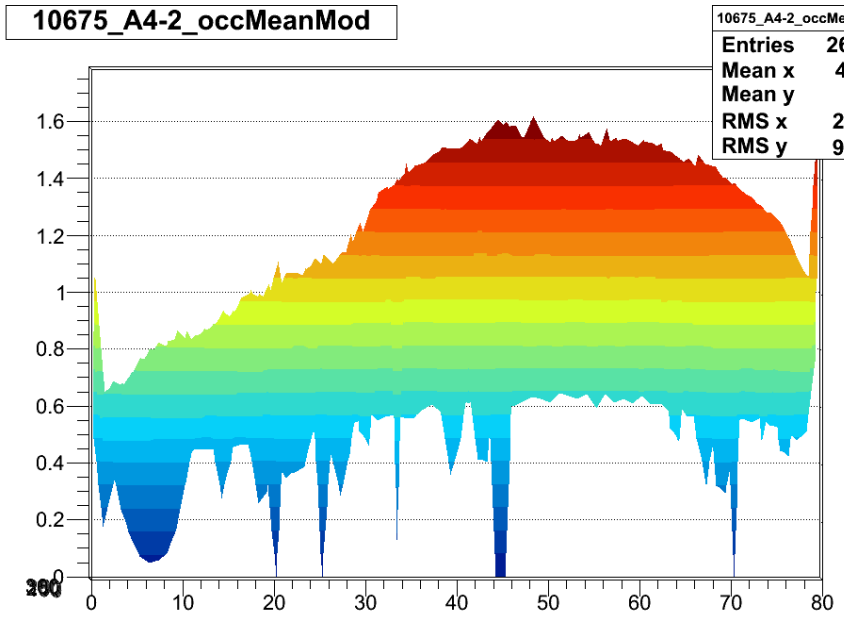


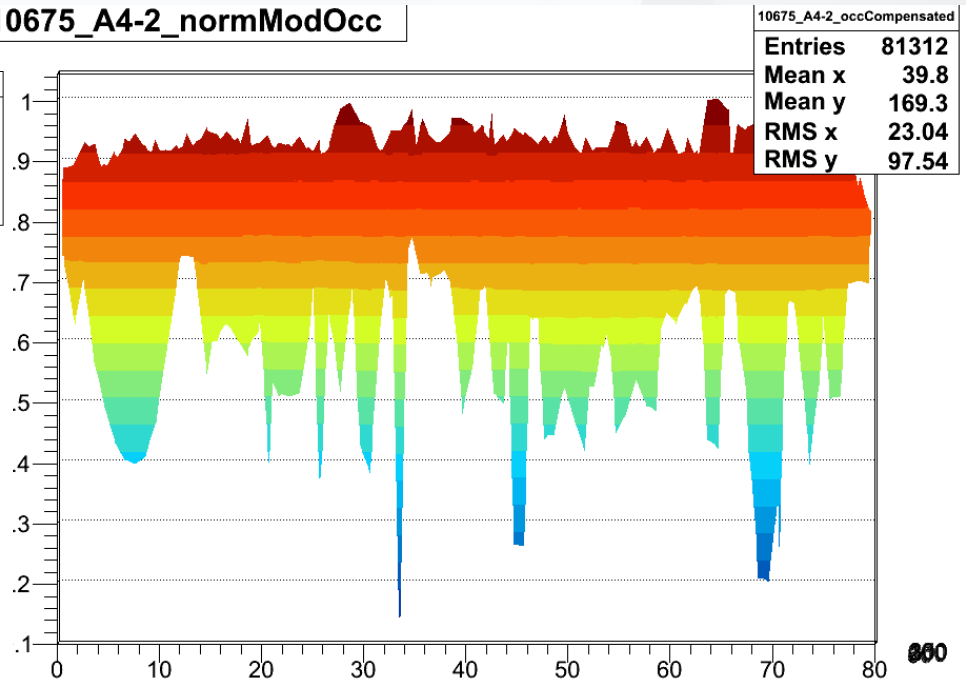
SR1 – IBL StaveTest setup. Note the linear motor above the stave, that moves sources over the modules for self-trigger tests.
Signals are passed from the test area to the DAQ in the racks.

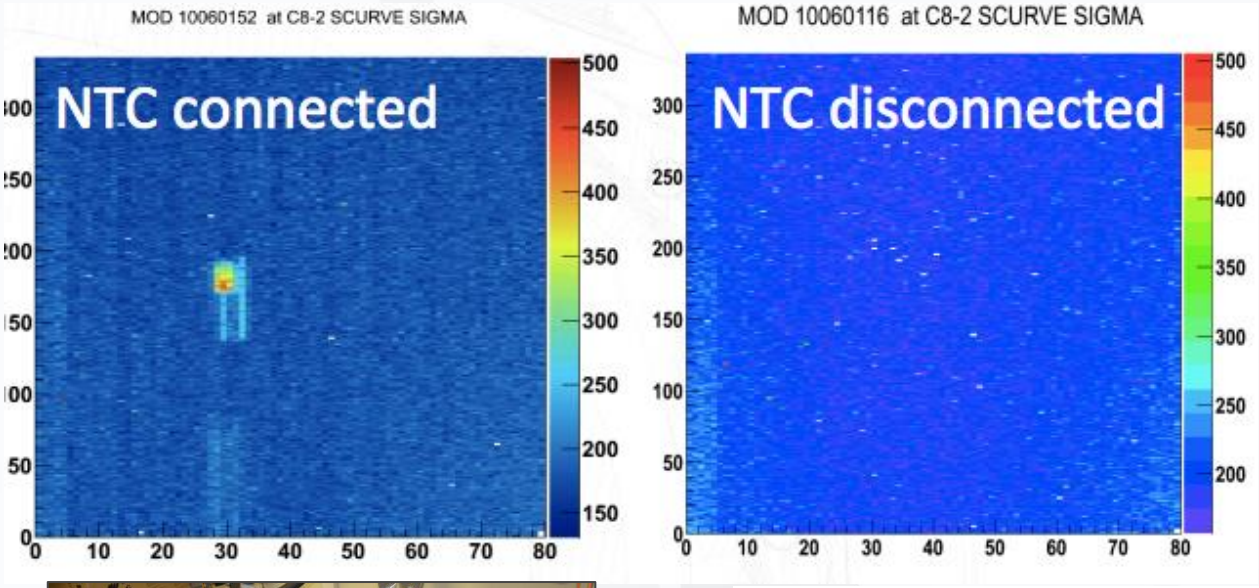


Self-triggered source scans have a heightened occupancy where the source is directly above the chip.
This makes features, such as areas of low collection efficiency, difficult to pick out.

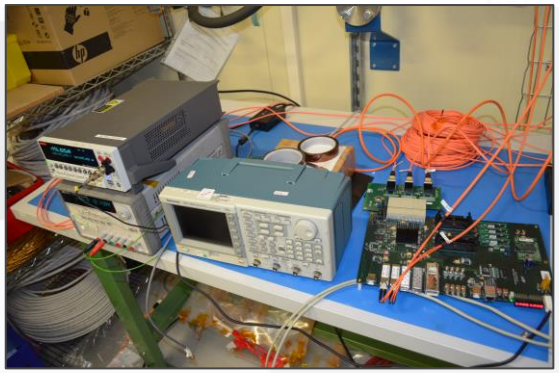
$$\text{occupancy} = \frac{\text{source rate}}{4\pi D_T^2} \times 0.05 \times 0.25$$



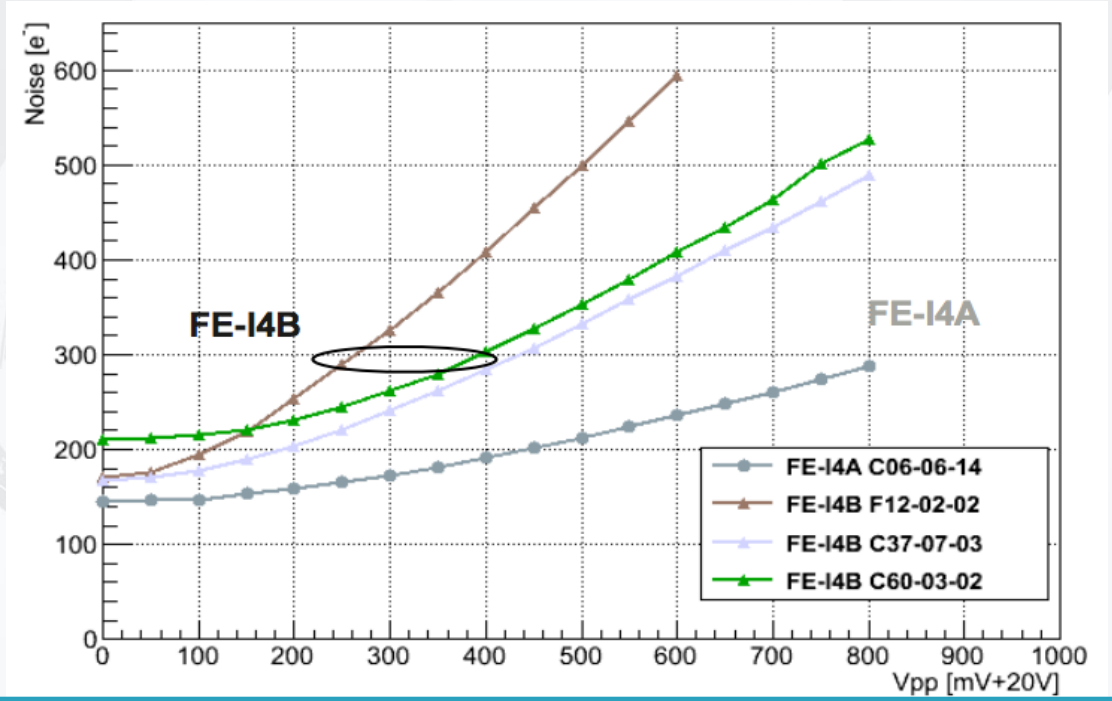




The NTC (negative temperature coefficient resistor) for a few 3D modules appears to be delivering high noise to the sensor. The reason for this is unknown: is it somehow coupling to the sensor?



High noise is observed in the 3D sensor modules. This noise changes with injected noise on the HV bias and should be compensated for by RC filters.



We've flown through the motivation for IBL and its make-up.

I've spoken briefly about the RCE analysis platform that forms a crucial part of the IBL QA procedure and how one of my tasks was adapting the self-trigger analysis.

My last month at CERN will be spent investigating the unaccounted for noise caused by the NTC and the 3D sensor noise response.

Questions?